EXHIBIT 3

[redacted]

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

TQ DELTA, LLC, *Plaintiff,* v. **COMMSCOPE HOLDING COMPANY, INC., COMMSCOPE INC., ARRIS US HOLDINGS, INC., ARRIS SOLUTIONS, INC., ARRIS TECHNOLOGY, INC., and ARRIS ENTERPRISES, LLC** *Defendants.*	CIV. A. NO. 2:21-CV-310-JRG (Lead Case)

TQ DELTA, LLC, *Plaintiff,* v. **NOKIA CORP., NOKIA SOLUTIONS AND NETWORKS OY, and NOKIA OF AMERICA CORP.,** *Defendants.*	CIV. A. NO. 2:21-CV-309-JRG (Member Case)

OPENING EXPERT REPORT OF GEORGE A. ZIMMERMAN, Ph.D. ON THE INVALIDITY OF THE ASSERTED CLAIMS OF THE FAMILY 2 PATENTS (U.S. PATENT NOS. 7,453,881; 9,300,601; 9,894,014)

of the art.

55. Therefore, I will analyze the prior art and other issues using this framework.

VI. LEVEL OF SKILL IN THE ART

56. I am informed and understand that the claims of a patent are judged from the perspective of a hypothetical construct involving a "person of ordinary skill in the art." The "art" is the field of technology to which the patent is related. I understand that the purpose of using the viewpoint of a person of ordinary skill in the art is for objectivity. I understand that a person of ordinary skill in the art is presumed to know and be familiar with all of the relevant art in the field at the time of invention.

57. I was also asked to provide an opinion regarding the skill level of a person of ordinary skill in the art of the Family 2 patents. I considered several factors, including the types of problems encountered in the art, the solutions to those problems, the pace of innovation in the field, the sophistication of the technology, my experience as a person who worked in the art on the Family 2 patents' priority date, and the education level of active workers in the field.

58. In my opinion, at the time of the alleged invention, a person having ordinary skill in the art would have had a bachelor's degree in electrical engineering or computer engineering and at least 5-6 years of experience in telecommunications or a related field, a Master's degree in electrical engineering and 2-3 years of experience in telecommunications or a related field, or a Ph.D. in electrical engineering with 1-2 years of experience in telecommunications or a related field.

59. I am qualified as a person of at least ordinary skill in the art, and my qualifications enable me to provide opinions regarding the Family 2 patents from the perspective of one of ordinary skill in the art.

VII. BACKGROUND OF THE TECHNOLOGY

A. ATM

60. Asynchronous Transfer Mode (ATM) is a high-speed connection oriented switching and multiplexing communication scheme that allows for high-speed telecommunications. ATM was developed in the 1980s and was used in connection with broadband in B-ISDN networks by the early 1990s. ATM is essentially a packet-switched communication scheme that utilizes fixed length packets or cells. ATM utilizes fixed size cells that are 53 octets long, with 5 bytes being header information and 48 bytes being payload information. The 48-byte cell payload may contain up to four bytes of information for the ATM adaptation layer, leaving at least 44 bytes for user data.

61. The term "asynchronous transfer mode" (ATM) was coined to contrast with "synchronous transfer mode" (STM). ATM is based on a time slotted transmission scheme in which data from different applications are multiplexed in accordance with their particular bandwidth, delay, and loss requirements. In ATM each time slot carries exactly one ATM cell. STM is also time slotted; however, in contrast to ATM, time is divided into a fixed number of slots which are grouped together to form a frame that repeats in time. All of the time slots that are located at the same relative position in each frame can be grouped to form a circuit consisting of a fixed number of time slots and a fixed bandwidth. STM is inefficient in that the bandwidth associated with each circuit is dedicated full-time to each particular user, regardless of whether the user has data which needs to be transmitted.

62. ATM addresses many of the deficiencies found in STM communication. ATM networks enable a wide variety of communication devices to share common carrier communication links on a demand driven, as needed basis. ATM networks utilize statistical multiplexing to provide bandwidth on an as needed basis to individual users. This obviates the

need for each user to have a dedicated, wideband communication channel for occasional communication. Instead, wideband communication is a shared resource which may be allocated on demand.

63. The ATM header information identifies the Virtual Path (Virtual Path Identifier or VPI), Virtual Channel (Virtual Channel Identifier or VCI), payload type, and cell loss priority. The VPI and VCI together form a Virtual Circuit. The ATM header also provides flow control and header error control. All of the cells of a Virtual Circuit (VPI/VCI) follow the same path through the network, which is determined during call set-up procedures or by assignment. The different users of the ATM network provide their cells to the ATM network interface where they are queued for cell assignment and transmission.

64. Cell transmission in an ATM network is causal, i.e., the cells in a connection (cells with the same VPI/VCI) arrive in order at the destination or far end. This is because the cells travel over the same Virtual Circuit. An ATM network can support different types of services, such as loss sensitive/delay sensitive, loss insensitive/delay sensitive, loss sensitive/delay insensitive and loss insensitive/delay insensitive. The required QoS (Quality of Service) is determined during call set-up.

B. Inverse Multiplexing over ATM

65. Multiplexing and inverse multiplexing had been in use for many decades in various networking and communications technologies by the 1990s. Inverse multiplexing was used with ATM to combine several communication lines into a higher bandwidth aggregate communication path.

66. The ATM Forum Technical Committee Inverse Multiplexing for ATM (IMA) Specification Version 1.0 (NOK00076647 – NOK00076781) ("IMA Spec 1.0") was published in July of 1997 by the ATM Forum. The purpose of IMA Spec 1.0 is to "to provide inverse multiplexing of an ATM cell stream over multiple physical links and to retrieve the original stream at the far-end from these links." IMA Spec. 1.0 at 12. It identifies as one of its objectives to "[u]se a cell based multiplexing technique for converting a single ATM stream into multiple lower speed ATM streams to be sent over independent links and retrieving the initial ATM cell stream from the links at the far-end." *Id.* at 20.

67. The specification "defines a new sublayer located between the Physical Layer Interface Specific Transmission Convergence (TC) sublayer and the ATM layer: the IMA sublayer." IMA Spec. 1.0 at 12. "[T]he introduction of ATM Inverse Multiplexers provides an effective method of combining the transport bandwidths of multiple links (e.g., DS1/E1 links) grouped to collectively provide higher intermediate rates." *Id.* "The ATM Inverse Multiplexing

technique involves inverse multiplexing and de-multiplexing of ATM cells in a cyclical fashion among links grouped to form a higher bandwidth logical link whose rate is approximately the sum of the link rates. This is referred to as an IMA group." *Id.*

68. IMA Spec 1.0 Figure 1 "provides a simple illustration of the ATM Inverse Multiplexing technique in one direction":

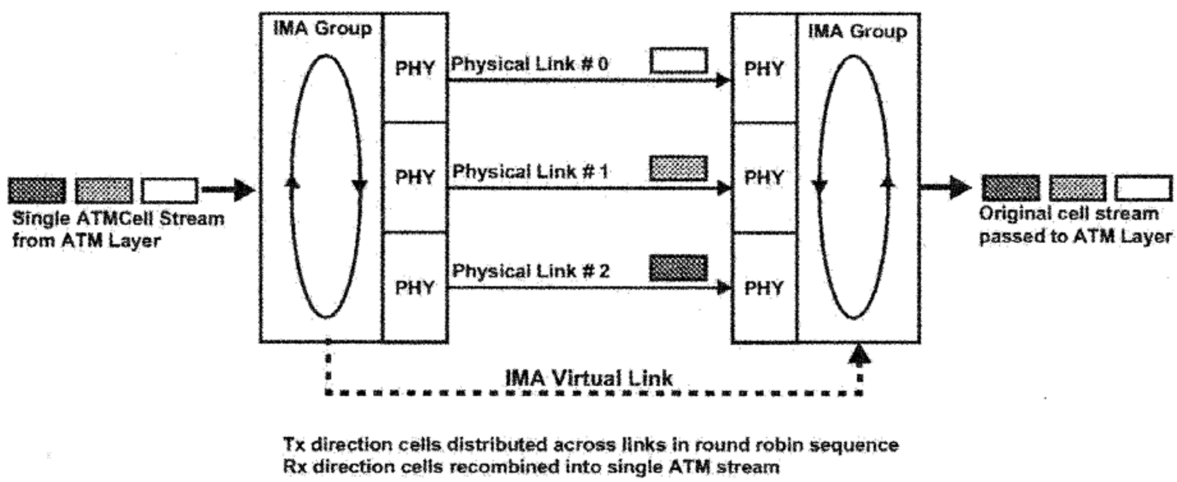

Figure 1 Inverse Multiplexing and De-multiplexing of ATM Cells via IMA Groups

IMA Spec 1.0 at 12. "The same technique applies in the opposite direction." *Id.*

69. IMA Spec 1.0 further explains that "IMA groups terminate at each end of the IMA virtual link. In the transmit direction, the ATM cell stream received from the ATM layer is distributed on a cell-by-cell basis, across the multiple links within the IMA group. At the far-end, the receiving IMA recombines the cells from each link, on a cell-by-cell basis, recreating the original ATM cell stream. The aggregate cell stream is then passed to the ATM layer." IMA Spec 1.0 at 13.

70. IMA Spec 1.0 teaches that "[t]he transmit IMA periodically transmits special cells that contain information that permit reconstruction of the ATM cell stream at the receiving IMA end after accounting for the link differential delays." IMA Spec 1.0 at 13. "These cells, defined

as IMA Control Protocol (ICP) cells, provide the definition of an IMA frame. The transmitter must align the transmission of IMA frames on all links . . . . This allows the receiver to adjust for differential link delays among the constituent physical links. Based on this required behavior, the receiver can detect the differential delays by measuring the arrival times of the IMA frames on each link." *Id.* The IMA receiver uses the ICP cells "to maintain link delay and protocol synchronization and to determine the differential delay between the links in the IMA group." *Id.* at 26.

71. An additional IMA Objective is to "[d]etect and reject lines with delay greater than the provisioned maximum differential delay tolerance." IMA Spec 1.0 at 20. "The Inverse Multiplexing function controls the distribution of cells onto the group of links made available to the IMA and handles differential delays and actions to be taken when links are added/dropped or when they are failed/restored. In the receive direction, the IMA performs differential delay compensation and recombines the cells into the original cell stream with the original inter-cell spacing or something." *Id.* at 22-23. "The receive IMA shall use the ICP cell to maintain link delay and protocol synchronization and to determine the differential delay between the links in the IMA group." *Id.* at 26. "Differential link delay can cause the reception to 'misaligned' in time; the alignment is recovered by the link delay synchronization mechanism." *Id.* at 30.

72. "The transmit IMA shall not introduce more than 2.5 cell times at the physical link rate of differential delay among the constituent links." IMA Spec 1.0 at 42. "The amount of link differential delay tolerated by an IMA implementation shall be up to at least 25 milliseconds when used over DSI/El links." *Id.* "The amount of link differential delay tolerance may be configured up to the maximum value supported by the IMA implementation." *Id.* "[B]oth ends of the IMA virtual link may be configured with different amounts of tolerable differential delay

(i.e., say one up to 25 ms and one greater than 25 ms)." *Id.* IMA Spec 1.0 also recognizes that the bit rates of the links in the IMA group and the maximum tolerable link differential delay are interrelated. *See* IMA Spec 1.0 at App'x B.3 (entitled "Maximum Link Differential Delay Limitation" and explaining, that to avoid confusion over which link has the shortest delay, "the differential link delay between the links with the shortest and the longest propagation delays" must never be "greater than one half of the time to transmit the [IMA Super-Frame]").

73. Another objective of IMA Spec 1.0 is to "[s]upport symmetric and asymmetric IMA configurations, and symmetric and asymmetric IMA operations." IMA Spec 1.0 at 20. *See also id.* at 33 ("The IMA protocol is defined to allow symmetric or asymmetric cell rate transfer over the IMA virtual link."). "Symmetrical Configuration and Operation" is defined as the mode where "the IMA interface is required to configure each IMA link in both transmit and receive directions" and "is also enforced to only transmit and receive ATM layer cells over links that are Active in both directions." *Id.* at 33. "Symmetrical Configuration and Asymmetrical Operation" is defined as the mode where "the IMA interface is required to configure each IMA links in both transmit and receive directions" and "is permitted to keep transmitting ATM layer cells over a link in the transmit direction while the link is not Active in the receive direction or vice versa." *Id.* "Asymmetrical Configuration and Operation" is defined as the mode where "the IMA interface is not required to configure all IMA links in both transmit and receive directions" and is also permitted to keep transmitting ATM layer cells over a link in the transmit direction while the link is not Active in the receive direction or vice versa." *Id.*

74. IMA Spec 1.0 includes a Section entitled "Quality of Service (QoS) Requirements." IMA Spec 1.0 at 35. It provides that "[t]he IMA interface shall support all ATM traffic/QoS classes supported at the ATM layer." *Id.*

75. By 1999, ATM inverse multiplexing was well known technology. Line cards implementing IMA were under development within several companies for use in DSLAMs, including PairGain's Avidia DSLAM.

C. DSL Communications

76. A modem—a modulator/demodulator—converts a stream of digital data into a signal that can be transmitted over a communication channel, and also receives such a signal and converts it back into a stream of digital data. The transmitting modem performs this conversion and transmits the signal over a communications channel, such as copper wire used for telephone service, cable, or a radio link. A receiving modem receives this signal and converts it back into the original digital data stream. As a modulator/demodulator, a modem contains both the capability to transmit (modulate) and receive (demodulate) such a signal.

77. DSL Technology broadly describes a set of technologies for transmitting digital signals over the copper telephone lines which typically represent the last link, or "last mile," to a subscriber's premises. This technology places a digital signal onto the copper wire to create a digital data connection at a much higher speed than could be achieved by, for example, the prior art of modulating an analog carrier to be carried through the telephone network as a voiceband signal over a much more limited frequency range.

78. DSL uses a multi-carrier modulation technique called DMT (Discrete MultiTone). DMT was not developed specifically for DSL. Multicarrier communications using DMT were well known to persons of ordinary skill in the field by the mid-1990s.

79. DSL signals use higher frequencies to transmit data than conventional voice circuits, and, because of this, experience greater signal loss with the distance of wire traversed than phone signals. The signal loss varies with the frequency being considered, and generally increases with frequency. The signal loss at a particular frequency, measured in deciBels, is

generally proportional to the length of the subscriber's copper telephone line, where, for example, a line 2000 feet long would have 2 times the decibel loss of a line 1000 feet long.

80. DSL was conceived of by the late 1980s to the early 1990s, and by the late 1980s development was well underway in industry and academia. Key aspects of DMT DSL were developed by John Cioffi and his colleagues at Stanford around this time. In addition to active work in the ANSI TIEI.4 DSL standards body, knowledge of DSL was disseminated in academic literature. Exemplary publications include the journal paper "Performance evaluation of a multichannel transceiver system for ADSL and VHDSL services" by Chow, Tu, and Cioffi in the *IEEE Journal on Selected Areas in Communications* (JSAC) in 1991 (NOK00077002 – NOK00077012) and "A Multicarrier Primer," by John Cioffi in 1991 (NOK00807636). These publications described the DMT approach for DSL which eventually evolved into the ADSL and VDSL standards.

81. In the late 1980s, the American National Standards Institute (ANSI) started the T1E1.4 Study Committee to develop standards for Digital Subscriber Line communications in the United States. In August of 1995, the Committee published T1.413-1995—"Network and Customer Installation Interfaces—Asymmetric Digital Subscriber Line (ADSL) Metallic Interface" (NOK00079270 - NOK00079455). The Tl.413-1995 standard detailed various features for ADSL, including modulation technique and initialization of an ADSL communications link. In 1998, the Committee published a second version of its standard—Tl.413-1998 (NOK00075245 - NOK00075508). I personally participated in the development of the ANSI Tl.413-1998 standard as a representative of Pairgain Technologies. ANSI T1.413-1998 at page x. At a high level, the purpose of these standards was to "define[] the minimal set of requirements to provide satisfactory simultaneous transmission between the network and the

customer interface of POTS and a variety of high-speed simplex and low-speed duplex channels." ANSI Tl.413-1998 at 2. To do so, the standards defined various detailed ADSL signal properties, including modulation, initialization, and numerous other properties of an ADSL device. ANSI T1.413-1998 at § 1.1, p.1.

82. One primary difference between ADSL systems and prior telephone carriers such as T1, or even prior DSL systems such as HDSL and Basic-Rate ISDN, was the ability of the transceiver to train to whatever rate the line supported. An important part of the DMT ADSL startup sequence in the T1.413-1995 and later standards was the measurement of the capability of each carrier of the many carriers to carry data (through its signal to noise ratio), and the adaptation of the transceiver to support rates up to the maximum rate supported on the line by aggregating each carrier's full data-carrying capabilities (for the given margin, under the given QoS condition). In contrast, in the early 1990s, PairGain Technologies, where I was employed, produced HDSL systems for T1 transport. These systems trained to the same rate (768 kbps per twisted pair) regardless of whether the line could support higher rates. Similarly, ISDN-Basic Rate transport (technically referred to originally as "DSL", and later as IDSL) was fixed at 160 kbps regardless of the capability of the line. While other DSL systems later developed variable rate capabilities to carry lower or higher rates, until the acceptance of ADSL rate adaptive technology, and these were preconfigured as fixed rate 64 kbps "DS0" (digitized voice) channels.

D. Use of Forward Error Correction (FEC) and Interleaving to Meet Quality of Service (QoS) Objectives and Relationship to Latency

1. Reed-Solomon Coding and Interleaving

83. DSL systems use error control techniques to both detect and correct errors in the transmitted bit stream. Starr, et al., *Understanding Digital Subscriber Line Technology* (1999) at

264-265 (NOK00731749 - NOK00732237) ("Starr"). Two primary error control techniques are forward error correction (FEC) and interleaving.

84. FEC is an error correction technique that works by adding redundancy to a message that allows errors in the transmitted bit stream to be corrected. A trivial example of FEC coding is a repetition code. For example, a single bit may be repeated three times to create a three-bit codeword. In other words, rather than transmitting simply a "0" a three-bit codeword "000" is transmitted. The receiving transceiver can then use majority voting to determine the received bit. In this example, received codewords "000", "00l", "010", and "100" would all be interpreted as a received "0" bit. As long as no more than one bit in the codeword is received in error, the receiving transceiver can correctly determine the received bit.

85. By the priority date of the Family 2 patents, error correction coding was a very well-developed field. Of particular interest here is Reed-Solomon coding, which is used in ADSL and VDSL, as well as many other communications systems. Reed-Solomon coding is a type of block coding technique that was developed by 1960. *See* I. S. Reed and G. Solomon, *Polynomial Codes over certain Finite Fields, J. Soc. Indust. Appl. Math*, 8, (1960) at 300-304 (NOK00809856 - NOK00809860).

86. Generally speaking, Reed-Solomon coding operates by combining a number of information symbols, usually denoted as K, with a number of redundancy symbols, usually denoted as R, to create a codeword, usually denoted as N. Thus, the relationship between the three parameters is N = K + R: total codeword size is the sum of the number of information symbols and the number of redundancy symbols.

87. Reed-Solomon coding can correct up to R/2 errors. As an example, particular to DSL communications, if R = 8 bytes, then up to 4 errored bytes of information in a codeword

can be corrected.

88. The use of Reed-Solomon coding in DSL systems was specified at least as early as the T.1413-1995 ADSL standard. Tl.413-1995 at 35.

89. Interleaving is another error control technique used in DSL communications. Interleaving works to protect against burst errors that can overwhelm the error correction capability of FEC by reordering the bytes of FEC codewords in a way that spreads the effect of burst noise events over multiple codewords. By spreading the effect of noise over multiple codewords, when the bytes of an FEC codeword are reordered on the receiving side, individual codewords will have fewer errored bytes and thus more likely to be correctable by FEC.

90. Interleaving was also a well-developed technique long before the priority date of the Family 2 patents. The use of interleaving, specifically convolutional interleaving, was specified in DSL systems at least as early as the Tl.413-1995 ADSL standard. Tl.413-1995 at 36. A convolutional interleaver is described by two parameters: the block length of the interleaver, usually denoted as I, and the interleaver depth, usually denoted as D.

2. <u>Latency Caused by FEC and Interleaving</u>

91. FEC, specifically Reed-Solomon coding, and interleaving both cause a delay in the processing of data in DSL systems. Because Reed-Solomon coding operates on a codeword basis, all K bytes of information data must be collected before the corresponding R redundancy bytes can be generated to create the transmitted codeword. On the receiving side, an entire transmitted codeword must be received before the receiver can decode the Reed-Solomon codeword. Interleaving then adds an additional layer of delay. On the transmitting side, rather than transmitting an entire codeword at one time, bytes of a codeword are delayed by an amount proportional to the interleaving depth D prior to the transmission. And again, on the receiving side, an entire codeword must be received and reordered in the proper order before the Reed-

Solomon codeword can be decoded. For the convolutional interleaver specified for DSL communications, the end-to-end interleaver delay, in milliseconds, is given by the equation (I-1) x (D-1) x 8 / Rate, where, again, I is the interleaver block length, D is the interleaver depth in bytes, and Rate is the bit rate over the line in kbit/s. G.992.1 at Section 7.6.3.

92. That both FEC and interleaving affect the end-to-end delay or latency of a communication link was well known in the art before the priority date of the Family 2 patents. For example, the relationship is explained in U.S. Patent No. 6,956,872 to Djokovic et al. (NOK00083305 – NOK00083320), which was filed on May 22, 2001, and claims priority to provisional applications filed on May 22, 2000, and August 18, 2000.

93. Djokovic describes the use of both a Reed-Solomon encoder and interleaver in DSL communications. *See*, *e.g.*, Djokovic at Fig. 1, 2:3-37. As described in Djokovic: "The system performance trade-off introduced by FEC in the form of Reed-Solomon coding and convolutional interleaving can be described as increased data transmission reliability at the expense of increased channel latency." Djokovic at 2:60-64. Describing Tl.413-compliant systems, Djokovic further explains: "The fast path is so called simply because the data does not undergo the additional processing of interleaving, and therefore does not experience the additional delay imposed by de-interleaving at the receiving end of the communication system. However, all data from the incoming bit stream is passed through the FEC, and therefore encounters the latency delay associated therewith." Djokovic at 3:5-11. Djokovic thus recognizes that both FEC and interleaving impose a delay on the bit stream.

3. Quality of Service

94. Some types of data transfer are delay (latency) sensitive but loss (error rate) tolerant, such as voice communications, while others are loss sensitive but delay tolerant, such as file transfers. These categories of data transfer, which differed based on their reliability and

latency requirements, are referred to variously as applications, transport classes, services classes, traffic classes, or, perhaps most commonly, Quality of Service (QoS) classes.

95. For example, Djokovic recognized that different applications can have different reliability and different latency requirements. Djokovic at 1:59-2:16. "For example, applications of pure data transfer are often not sensitive to latency delays, while real-time voice communications are sensitive to latency delays." Djokovic at 1:60-63. Similarly, data transfers may require high reliability, while voice transmissions can tolerate transmission errors. Djokovic at 2:3-16.

96. Djokovic also discusses varying FEC and interleaving parameters in order to provide the required level of reliability/latency on a given latency path: "[A] fundamental aspect of the preferred embodiment of the invention relates to the ability to vary the level or depth of encoding of a DSL bit stream, based upon the desired latency in communicating that bit stream. As previously described, certain applications like data transfer may not be sensitive to latency delays, and therefore a higher degree of encoding is often desired. Other applications, like voice communications, desire minimal latency delays, while tolerating certain levels of transmission error." Djokovic at 4:42-54. *See also* Djokovic at 5:45-50, 6:41-54.

97. Similarly, the 320 patent explains that "[i]n most cases, it is the FCI block that is optimized for a specific application because the FCI block has significant control over three of the four parameters mentioned above: bit error rate, latency and immunity to impulse noise....As an example, if low BER and immunity to impulse noise are required for a specified application, the transceiver may include FEC codes and interleaving. If for another application low latency is important but a higher BER and/or burst errors resulting from impulse noise are tolerable, convolutional codes and no interleaving may be used." 320 patent at 2:15-30.

98. The 320 patent also generally discusses the choice of different error correction techniques and their corresponding parameter values for different application sets. 320 patent at 5:40-7:34. Often, and as further described below, the BER and latency tolerances or requirements for a given application or type of data transfer are referred to as "quality of service" (QoS) classes, metrics, or requirements or at times as transport classes or service classes.

99. Thus, as shown by Djokovic and the 320 patent, a POSITA would have been aware that configurable FEC and interleaving parameters in DSL systems allowed for the provision of different qualities of service depending on the application being supported. This connection between QoS and corresponding FEC and interleaving parameters (and the resulting latency) is further demonstrated in, for example, Broadband Forum Recommendation TR-042: ATM Transport over ADSL Recommendation Issue 1.0, which issued in August 2001 ("TR-042"). TR-042 explains the following about latency under a section entitled "Quality of Service (QoS)": "The ADSL PHY Recommendations specify a configurable interleaver for protection against impulse noise. The interleaver configuration allows the Network Operator to deliver different service qualities by adjusting the effectiveness of the Forward Error Correction mechanism over the ADSL Access Network. This interleaver mechanism introduces additional latency as a side-effect." This reference is "incorporated" into the specification of the Asserted Patents "by reference in its entirety." '881 patent at 1:22-25.

4. Latency Restrictions in DSL Systems

100. Before the priority date of the Family 2 patents, existing DSL systems included latency constraints on the communications channel. For example, Tl.413-1995 defines a payload transfer delay that is no more than 2 ms for channels assigned to the fast buffer and no more than 20 ms for channels assigned to the interleaved buffer. Tl.413-1995 at 23. ADSL's definition of two latency paths (a fast path and a slow or interleaved path) is itself a broad recognition of

latency constraints or requirements associated with different QoS requirements for various kinds of data streams.

101. Tl.413-1995 also defines several default configurations that would result in a corresponding default delay. Specifically, Tables 18 and 19 of Tl.413- 1995 provide default FEC and interleaving parameters for the ATU-C transmitter (downstream direction)—number of FEC redundancy bytes, number of symbols per FEC codeword, and interleaver depth—for different defined transport classes, each of which is associated with a data rate. Tl.413-1995 at 29-30. As Tl.413-1995 explains, the delay associated with these default settings is 16 ms relative to the fast buffer. Tl.413-1995 at 29. Tl.413-1995 similarly provides default FEC and interleaving parameters for the ATU-R transmitter (upstream direction) in Table 26. Tl.413-1995 at 54.

102. ITU-T recommendation G.992.1 also defines a cell transfer delay. As with Tl .413-1995, G.992.1 requires payload transfer delay that is no more than 2 ms for channels assigned to the fast buffer. For the interleaved buffer, the payload transfer delay is defined to be no more than a variable amount calculated based on S, the number of symbols per codeword, and D, the interleaver depth, again relative to the fast buffer. G.992.1 at 20-21.

5. Determination of FEC and Interleaving Parameters in Existing DSL Systems

103. Tl.413-1995 also defines initialization messages that allow transceivers to exchange and agree on different parameters. It defines a C-RATES1 message in which the ATU-C communicates four options for: the number of bytes assigned to the fast and interleaved buffers for various channels, the number of redundancy bytes for the fast and interleaved buffers (upstream and downstream), the number of symbols per FEC codeword (upstream and downstream), and the interleaver depth (upstream and downstream). Tl.413-1995 at 98-99. The R-RATES1 message contains similar information, although the FEC and interleaving

information is limited to the upstream direction. Tl.413-1995 at 102.

104. The contents of the C-RATES1 and R-RATES1 messages are summarized in Figure 33.

C-RATES1	Prefix	Option 1			Option 2			Option 3			Option 4		
		B_F	B_I	*RRSI*	B_F	B_I	*RRSI*	B_F	B_I	*RRSI*	B_F	B_I	*RRSI*
Number of bytes	4	10	10	10	10	10	10	10	10	10	10	10	10

R-RATES1	Prefix	Option 1			Option 2			Option 3			Option 4		
		B_F	B_I	*RRSI*	B_F	B_I	*RRSI*	B_F	B_I	*RRSI*	B_F	B_I	*RRSI*
Number of bytes	4	3	3	5	3	3	5	3	3	5	3	3	5

Figure 33 – C-RATES1 and R-RATES1 (12.6.2 and 12.7.4)

105. The R-RATES2 message responds to the C-RATES1 message with the option of the highest data rate that can be supported. T1.413-1995 at 110.

106. After the ATU-C makes a final determination on transmission parameters, the ATU-C transmits the C-RATES2 message that indicates the chosen transmission option from the C-RATES1 and R-RATES2 messages. Tl.413-1995 at 106-107. The chosen option will then have a latency associated with it based on the agreed upon transmission parameters.

107. The ITU-T G.992.1 recommendation defines similar messages (NOK00077580 – NOK00077835). G.992.1 also defines a C-RATES1 message with similar content and provides limitations on the allowable values for FEC redundancy bytes, number of symbols per FEC codeword, and interleaver depth. G.992.1 at 95-96. The specific constraints are shown in the excerpt below.

- $\{RS_F, RS_I, S, I, FS(LS2)\}$ is a ten-byte quantity comprising (one byte each):
  - the RS_F field, containing RS_F, the number of parity bytes per symbol in the downstream fast buffer, with $0 \le RS_F \le 63$ and RS_F equal to R_F (R_F is defined in 7.4.1.2.1);
  - the RS_I field, containing the value of RS_I, the number of parity bytes per symbol in the downstream interleave buffer, with $0 \le RS_I \le 63$ and RS_I equal to R_I/S (R_I and S are defined in 7.4.1.2.2);
  - the S field, containing the value of S, the number of symbols per codeword (downstream), with $0 \le S \le 63$;
  - the I field, containing the eight least significant bits I_7 to I_0 of the downstream interleave depth in codewords, with $0 \le I \le 128$;
  - the FS(LS2) field is a field of eight zeros;
  - the same five quantities $\{RS_F, RS_I, S, I, FS(LS2)\}$ in the upstream direction (one-byte each, in that order).

G.992.1 at 96.

108. The corresponding description of the R-RATES1 message is given on pages 99-100 of G.992.1.

109. G.992.1 also defines an additional C-RATES-RA message that is used to send four new proposed configurations that are closer to the optimum bit rate than the C-RATES1 message. G.992.1 at 104-105. Although, as shown below, the syntax of the message is changed from C-RATES1, the parameters communicated are the same:

Table 10-10/G.992.1 – C-RATES-RA

	Option 1			Option 2			Option 3			Option 4		
	B_F	B_I	*RRSI*	B_F	B_I	*RRSI*	B_F	B_I	*RRSI*	B_F	B_I	*RRSI*
Number of bytes	10	10	10	10	10	10	10	10	10	10	10	10

Table 10-11/G.992.1 – RRSI fields of C-RATES-RA

	← bits →							
fields	7	6	5	4	3	2	1	0
RS_F	0	0	value of RS_F MSB ... LSB					
RS_I	B_8 (AS0)	0	value of RS_I MSB ... LSB					
S	I_9	I_8	value of S MSB ... LSB					
I	I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0
FS(LS2)	value of FS(LS2) *set to* $\{00000000_2\}$							

110. G.992.1 also defines R-RATES-RA and R-RATES2 messages that respond to the C-RATES1 and C-RATES-RA messages, respectively, with the option of the highest supported

data rate. G.992.1 at 112, 114.

111. G.992.1 also defines a C-RATES2 message that communicates the chosen transmission options. G.992.1 at 108.

112. Similarly, ADSL2 and VDSL2 systems do not finally determine the data rate before selecting the FEC and interleaving parameters. *See, e.g.,* G.992.3 (4/2009) §§ 7.10.3, 8.13.6.1.4, 8.13.6.2.4; G.993.2 (12/2011) at §§ 12.3.5.2.1.3, 12.3.5.2.2.3, 12.3.5.2.1.4, 12.3.5.2.2.4.

E. DSL Access Platforms, including DSLAMs

113. While in the early 1990s, DSL systems were generally integrated as single line card units, by the late 1990s, implementers of DSL systems, including SDSL, ADSL, VDSL, and proprietary links, were developing multi-port and multi-line card access multiplexers optimized for DSL. These were known as DSL Access Multiplexers or DSLAMs for short (*see, e.g.,* Starr at 403-410), and contained DSL transceivers to serve multiple customers and multiple customer premises in a single platform, along with ATM multiplexing and QoS protocols. Indeed, it was estimated that a single DSLAM would be capable of terminating between "200 and 500 ADSL lines." *Id.* at 396. "The back-end network will connect all the Central Offices that serve DSL customers to all the service providers who wish to be reached by users served by DSL." *Id.*; *see also* 404.

114. While initially envisioned for ADSL, by the time of the patent, DSLAMs from multiple vendors, including Nokia (then Alcatel), PairGain, and Cisco integrated multiple types of DSL ports and protocols, including ADSL, SDSL, VDSL, as well as conventional STM ports on a single access switch. *See, e.g., Pairgain Wins $100 Million Deal to Equip European Data CLEC Riodata* (June 2000) (NOK00809855) https://www.premisesnetworks.com/doc/pairgain-wins-100-million-deal-to-equip-europ-0001 , or *The Application of Various Digital Subscriber*

Line (xDSL) Technologies to ITS: Traffic Video Laboratory Assessments, MitreTech, Paper MT1999-27 (February 1999) (NOK00809698 - NOK00809820) https://rosap.ntl.bts.gov/view/dot/2968/dot_2968_DS1.pdf.

115. In the 1990s and early 2000s, a person of ordinary skill in the art would have been aware of the 'interoperability' of VDSL and ADSL within a single system or DSLAM. Specifically, it was known that a VDSL linecard with VDSL transceivers could also operate in downgraded ADSL mode and connect to an ADSL modem/CPE. For example, in the article *VDSL, from Concept to Chips*, Nokia described such functionality as ". . . allowing for interoperability between ADSL and VDSL. Interoperability means that a VDSL modem at one end of the line, whether LT or NT, can communicate with an ADSL modem at the other end, at a reduced speed." *VDSL, from Concept to Chips*, P. Spruyt, P. Antoine, S. Schelstraete, W. De Wilde, C. Gendarme, Proceedings ESSCIRC'2000, pp. 30-37, September 19-21, 2000, Stockholm, Sweden (NOK00805287 - NOK00805294)*; see also VDSL, fiber-fast data transmission over copper pairs*, P. Antoine, W. De Wilde, C. Gendarme, S. Schelstraete, P. Spruyt, *Alcatel Telecommunications Review*, 4th quarter 2000 NOK00805295 - NOK00805305); David Johnson, *Copper Fire: Still Faster Traffic – Both Ways*, Newslink Vol. 8, No. 2 (June 2000) (NOK00805306 - NOK00805307) ("Alcatel's subscriber access multiplexer is the same for both ADSL and VDSL modems, enabling operators to offer both services more efficiently. Paul Spruyt, vice president for VDSL at Alcatel, has focused on the VDSL technology since 1995. . . . With DMT being the standard linecode for ADSL, the choice of DMT for VDSL also gives the possibility of insuring interoperability between both services. This means that an ADSL modem at one end of the line, whether LT or NT, can communicate with a VDSL modem at the other end. As it is expected that ADSL will be widely deployed, interoperability of VDSL with

ADSL could pave the way for a smooth migration from ADSL to VDSL (and vice versa) with cost benefits for operators and end-users."); *VDSL, the Copper Super Highway*, Alcatel (1999) (NOK00805360 - NOK00805361) ("Alcatel's VDSL solution is based on DMT (Discrete MultiTones), ensuring spectral compatibility with existing services, robustness to radio interference and ADSL interoperability." *VDSL, the Copper Super Highway*, Alcatel (2000) (NOK00805362 - NOK00805363) ("With DMT being the standard linecode for ADSL, the choice of DMT for VDSL also gives the possibility of insuring interoperability between both services. This means that an ADSL modem at one end of the line, whether LT or NT, can communicate with a VDSL modem at the other end. As it is expected that ADSL will be widely deployed, interoperability of VDSL with ADSL could pave the way for a smooth migration from ADSL to VDSL (and vice versa) with cost benefits for operators and end-users.").

116. It was also known that a "DSL access network can transport data traffic for many different applications between the user and service provider." Starr at 398. In ADSL, a DSLAM could transfer data using ATM and IP. Starr describes a structure in which "an arrangement of ADSL modems (ATU-Cs) connected to an IP router to an IP router through an Ethernet hub." *Id.* at 402. In addition, "ATM architectures for ADSL connect a user's site to multiple service providers through a network based upon ATM transport." *Id.* at 403. "At the customer premises, the ADSL modem may be integrated into the PC, be connected to the PC over a serial connection such as the Universal Serial Bus (USB), be integrated by the ADSL modem into the PC, or implement some form of premises network, either Ethernet or ATM." *Id.* at 404; *see also* 405 – 410 (14.4.3 RFC 1483, 14.4.4 PPP over ATM, 14.4.5 Tunneled Gateway Architecture, 14.4.6 PPP Terminated Aggregation).

117. Further, the mixture of ADSL and VDSL ports as they exist in ADSL and VDSL

carrying IP packets in ATM mode, i.e., a VDSL IMA link, and an ADSL transceiver carrying native ATM, was well known in the art. A person of ordinary skill in the would have appreciated that carrying multiple services over ATM was well known at the time of the patent, as illustrated by ATM Forum and Broadband Forum specifications. Starr at 403-410; Multi-Protocol Over ATM, Version 1.0, AF-MPOA-0087.000 (July 1997) (NOK00809544 - NOK00809697).

F. Bonding and Inverse Multiplexing

118. As I explained above, longer and/or noisier subscriber lines typically cannot support bit rates that are as high as those that shorter, less noisy lines can support. Consequently, service providers sometimes cannot provide a target bit rate to a customer over a single subscriber line.

119. As I also explained above, the cables providing twisted pairs to subscriber premises and businesses can contain more than one twisted pair. Service providers can take advantage of these additional twisted pairs to provide higher-speed DSL services to customers.

120. *Bonding* is a technique used in DSL that allows service providers to deliver higher data rates to customers by using more than one subscriber line to deliver data. In bonding, instead of using a single transmitter to transmit the entire data stream over a single subscriber line, the data stream is divided into two or more parallel data streams, each of which is then transmitted over a separate subscriber line. At the far end, the original data stream is reconstructed from the individual data streams received over the separate subscriber lines. The term "bonding" refers to the aggregation of two or more twisted pairs together to form a single logical link of higher combined bandwidth than each of the constituent twisted pairs.

121. Bonding implements the function known as inverse multiplexing, which I explained above. Therefore, the terms "inverse multiplexing" and "bonding" are largely

interchangeable in the DSL context, and I use them interchangeably herein.

G. <u>Combination of Bonded and Unbonded Ports</u>

122. While the concept of bonding allows for to the aggregation of two or more twisted pairs together to form a single logical link of higher combined bandwidth than each of the constituent twisted pairs, it is often the case that a single twisted pair can be used on its own. And indeed, the combination of bonded and unbonded twisted pair wires was also contemplated prior to filing of the patents. The Asserted Patents state that "it should be appreciated that any combination of "bonded" and unbonded, i.e. traditional, ADSL PHY's, may be configured between the access node 100 and the broadband network determination." *See, e.g.*, '014 patent at 4:45-4:62.

123. The prior art recognized this structure as well. For example, Witkowski (NOK00082678) disclosed VLANs that included bonded and non-bonded ports. *See* Witkowski at 19:13-16 ("The default bit map for each of the ports PORT0-PORT4 includes all of the non-bonded ports PORT0-PORT4 plus one of the bonded ports."). Similarly, Kozaki (NOK00081147) discloses an ATM cell switching system where some transceivers are connected to a multiplexer and others are not. *See* Kozaki at Figure 1. Further, the Nokia A1000 ASAM ADSL release R3.1 disclosed "[a]ny combination" of IMA protocol or native mode links. Technical Requirement Specification (TRS) on Inverse Multiplexing for ATM (IMA) functionality (NOK00291535) at 7 and Figure 2. Accordingly, such a concept was appreciated and well known in the art prior at the time of the alleged invention.

H. <u>DSL Recommendations Relating to Bonding</u>

124. As I mentioned above, the 2001 version of ITU-T G.991.2 specified an optional four-wire mode whereby a single-pair high-speed digital subscriber line (SHDSL) transceiver would transmit data to a SHDSL receiver using two twisted pairs. In January of 2005, the ITU-T

approved two new Recommendations specifically specifying bonding for DSL in general.

1. G.998.1

125. G.998.1 is entitled "ATM-based multi-pair bonding" and describes a method for bonding multiple DSLs to transport ATM streams. G.998.1 at i. G.998.1 was developed to meet several objectives, including dynamic removal and restoration of pairs without human intervention, support of pairs having different data rates, the ability to bond as few as two or as many as 32 pairs, and a maximum one-way bonding delay of 2 ms. *Id.* at § 1. With respect to latency, G.998.1 states that "[i]mplementations should equalize latency on each link," but "when bonding DSL types that may have different latencies due to different values in PHY layer parameters, implementations should be able to tolerate at least 4 ms of differential delay." *Id.* at § 6.1, n.4.

126. To compensate for the differential delay, the transceivers on both ends of a bonded group track the differential delay between provisioned links using timestamps provided by the transmitter. *Id.* at § 6.5. The transmit entity on the customer's side of the bonded group is capable of delaying transmissions on a line-by-line basis using a buffer space. *Id.* at § 6.6. The size of the buffer is sufficient to compensate for 20 ms of differential delay at 3 Mbit/s. *Id.* As a result of the compensation, the "differential delay in the upstream direction should be at most 1 ms, excluding ATM and other transmission delays." *Id.*

127. G.998.1 includes an optional initialization procedure that allows the settings of the individual DSL transceivers to be optimized. *Id.* at Appendix I. Using this procedure, a candidate line to be bonded is "pre-trained" to determine its capabilities and delay information. *Id.* A network management system processes the obtained information to "tune" the configuration parameters of the candidate DSL transceivers, such as the minimum and maximum net data rate and the minimum and maximum delay parameters, "to collectively reflect the

bonding group's aggregate rate and delay variance tolerance requirements." *Id.* The parameters are passed to the candidate DSL transceivers in the CO, which are then "initialized in such a way as to support the bonding group's aggregate rate and delay variance requirements." *Id.* The bonding initialization procedure follows. *Id.*

2. G.998.2

128. G.998.2 is entitled "Ethernet-based multi-pair bonding" and describes a method for bonding of multiple DSLs for Ethernet transport. G.998.2 at i. G.998.2 "builds on the IEEE 802.3ah-2004 methods" and specifies changes to clause 61 of the IEEE 802.3ah-2004 standard. G.998.2 at 1. The IEEE 802.3ah-2004 standard specifies the transport of Ethernet data over voice-grade copper and provides for the optional transmission of Ethernet data over multiple copper pairs. IEEE 802.3ah-2004 at § 61.1 (NOK00808904 - NOK00809543).

129. IEEE 802.3ah-2004 defines a "physical medium entity" (PME) as an individual loop (i.e., subscriber line) contained within an aggregated group, where an aggregated group is a collection of PMEs. G.998.2 at § 3.10; IEEE 802.3ah-2004 at §§ 1.4, 1.5. It also defines an optional PME aggregation function (PAF) that "allows one or more PMEs to be combined together to form a single logical Ethernet link." IEEE 802.3ah-2004 at §§ 61.1.4.1.3, 61.2.2.

130. IEEE 802.3ah-2004 places restrictions on whether PMEs can be aggregated together. *Id.* at § 61.2.2.5. One restriction is on the differential latency, which is the variation in the time required to transmit data across different PMEs. *Id.* Specifically, "[t]he differential latency between any two PMEs in an aggregated group shall be no more than [the specified value of] maxDifferentialDelay." *Id.* Another restriction is on the maximum difference between the bit rates of the aggregated PMEs. IEEE 802.3ah-2004 requires that "[t]he highest ratio of speeds between any two aggregated links shall be [the specified value of] maxSpeedRatio." *Id.* If initialized links have a differential latency that is within the maxDifferentialDelay value and a bit

rate difference within the maxSpeedRatio value, they may be aggregated. IEEE 802.3ah-2004 states that multiple aggregated links in the same environment "should be optimized to have similar latencies," and that "[t]he PMD control of aggregated links controls the maximum latency difference between any two aggregated links," which can be accomplished "by configuring the bit rate, error correction and interleaving functions in the PMA/PMD of each link." *Id.*

VIII. OVERVIEW OF PRIOR ART

A. U.S. Patent No. 6,222,858 to Counterman

131. U.S. Patent No. 6,222,858 to Counterman ("Counterman") (NOK00081699 - NOK00081715) was granted on April 24, 2001, from an application filed on February 10, 1999. Based on its issue and filing dates, I have been informed and understand that Counterman is prior art to the Family 2 patents under at least 35 U.S.C. § 102(a) and (e) (pre-AIA).

132. Counterman "relates to inverse multiplexing for Asynchronous Transfer Mode ('ATM') over communication links with different transmission rates and/or delays." Counterman at 1:8-11. Counterman accomplishes this objective through "link grouping of communications links with different transmission rates and delay," which "supports links which use a portion of the link bandwidth for one QoS objective (e.g., low delay) and another portion for another QoS objective (e.g., low cell loss)." *Id.*

133. Counterman provides a detailed overview of ATM in the "Description of the Related Art" section of the specification. He explains that "[a]n ATM network can support different types of services, such as loss sensitive/delay sensitive, loss insensitive/delay sensitive, loss sensitive/delay insensitive and loss insensitive/delay insensitive. The required QoS (Quality of Service) is determined during call set- up." Counterman at 2:10-14.

134. Counterman also explains inverse multiplexing: "ATM inverse multiplexers (IMA)

bonded receivers" to reflect no more than a generic, or abstract, concept in telecommunications – namely, the use of two or more ordinary transceivers that happen to be co-located (e.g., situated in the same DSL access multiplexer (DSLAM) at the central office) to transmit or receive data. A bonded transceiver, even as the Court has construed that term, is a kind of transceiver whose functionality was already well-understood, routine, and conventional, and which added no inventive feature to claims 17 and 23. That the bonded transceivers are "configurable to transmit or receive a different portion of the same bit stream via a different one of the physical links" does not require any operation of the transceivers that differs from their operation when they are not bonded. As a person having ordinary skill in the art as of the '881 patent's priority date would have understood, the splitting of a bit stream into different portions would occur in advance of the different portions being provided to the "bonded transceivers" for transmission, at the multi-pair multiplexer. Each transceiver neither knows nor cares that it is transmitting (or receiving) only a portion of a bit stream. Each simply transmits (or receives) the bit stream provided to it, regardless of how that bit stream might be interpreted outside of the "bonded transceivers."

232. In my opinion the "at least one transmission parameter value" recited in claims 17 and 23 does not add any inventive concept. The "transmission parameters" recited in claims 17 and 23 have been present, and configurable, in DSL transceivers since the first ADSL standard, T1.413 Issue 1, released in 1995.

233. In addition, the reduction in the configuration latency difference described in the specification and claimed in claims 17 and 23 is accomplished using conventional schemes, for example, by setting the transmission parameters on different DSL PHYs equal to one another so that the configuration latencies are the same, or, if the data rates of those DSL PHYs differ, choosing settings that result in identical configuration latencies. *See, e.g.*, '881 patent at col.

6:56-65 ("Another effective method of reducing the difference in latency between DSL PHYs is mandate that all DSL PHYs are configured with transmission parameters in order to provide the same configuration latency. An exemplary method of accomplishing the same configuration latency is by configuring the exact same data rate, coding parameters, interleaving parameters, etc. on all DSL PHYs. Alternatively, different PHYs can have, for example, different data rates but use the appropriate coding or interleaving parameters to have the same latency on all the bonded PHYs."). The concept of changing settings in order to change delay was known prior to the '881 patent. *See, e.g.*, U.S. Patent No. 6,870,888, at 3:4-60.

234. The specification for the '881 patent acknowledges the bonded transceivers will reduce the differential delay between different communication paths by selecting settings for the transceivers on those communication paths. *See* '881 patent; at 1:42-47; 6:56-65; 7:22-34. The existing specifications for ADSL predating the alleged time of the invention reflect that selecting settings for a transceiver is a conventional task. *See, e.g.*, T1.413 Issue 1 at § 5.4 (specifying "fast" and "interleave" paths); § 6.2.1.2.1 (number of FEC redundancy bytes selected in accordance with information received during initialization procedure); § 6.2.1.2.2 (providing default settings for FEC and interleaver). *See also* G.992.1 (06/99) at i ("This Recommendation describes Asymmetric Digital Subscriber Line (ADSL) Transceivers on a metallic twisted pair that allows high-speed data transmission between the network operator end (ATU-C) and the customer end (ATU-R). . . . A single twisted pair of telephone wires is used to connect the ATU-C to the ATU-R. The ADSL transmission units must deal with a variety of wire pair characteristics and typical impairments (e.g. crosstalk and noise)."); *id.* at § 10.8.3 (initialization message C-RATES-RA specifies forward error correction and interleaver parameters). The twisted pairs form the physical link between a subscriber and a central office, and transport data

between the two. Thus, the concept of using "bonded transceivers" does not, in my opinion, in any way distinguish claims 17 or 23 from the abstract idea of setting conventional parameters of conventional transceivers to attempt to reduce a differential delay between multiple communication paths.

235. In my opinion, claims 17 and 23 of the '881 patent also do not solve any specific problem with respect to the operation of the bonded transceivers simply because each bonded transceiver employs a different data rate. Using inverse multiplexing over communication links supporting different bit rates was well known as of the '881 patent's priority date. *See, e.g.*, RFC 1990 at 8 ("A possible strategy for contending with member links of differing transmission rates would be to divide the packets into segments proportion [sic] to the transmission rates. Another strategy might be to divide them into many equal fragments and distribute multiple fragments per link, the numbers being proportional to the relative speeds of the links.").

236. In sum, it is my opinion that the elements of the claims—whether considered individually or as a whole—do not cover any "inventive concept." That signal processing performed by a transmitter and receiver imposes latency in the communication of data was well understood, routine, and conventional to one of ordinary skill in the art, as was the need to constrain latency between communication paths of an inverse multiplexed system to keep messages or parts of messages from being received too far apart in time, so as to reduce and constrain buffering requirements at the receiver. In my opinion, the use of settings such as "transmission parameters" to set or adjust delay was well-understood, routine, and conventional to one of ordinary skill in the art at the time of the alleged invention.

237. As I already noted, the '881 patent describes and claims conventional hardware, a plurality of bonded transceivers. Consequently, to a person having ordinary skill in the art, the

ordinary skill would understand the each of the bonded links LINK-1, LINK-2, LINK-L associated with blocks labeled TC-l/PMD-1, TC-2/PMD-2, and TC-L/PMD-L, respectively, to comprise a bonded transceiver. FIG. 4 likewise discloses bonded links provided by bonded transceivers. Dr. Cooklev has likewise confirmed that Counterman discloses bonded transceivers. 2Wire Trial Tr. at 676:24-677:2.

282. Notably, the ’881 patent does not mention a “plurality of bonded transceivers” within the specification, but instead refers to combining “multiple DSL PHY's, i.e., multiple twisted wire pairs” (’881 patent at 1:61), or “two ADSL PHYs” that “are 'bonded' together” (881 patent at 4:29-45). The “plurality of bonded transceivers” of the Asserted Claims must therefore be the bonded PHYs referenced in the specification. Otherwise, the claim term “plurality of bonded transceivers” is without support in the specification.

283. Furthermore, Counterman's teaching of inverse multiplexing teaches the “plurality of bonded transceivers” as that phrase is used in the ’881 patent. *See* Counterman at 2:42-51 & Fig. 1 (“The general concept of ATM inverse multiplexing is shown in FIG. 1. In the transmit direction, an ATM cell stream 100 is received from the ATM layer and distributed on a cell by cell basis by the ATM inverse multiplexer 102 to a number of physical links 103, 104, and 105 which collectively make up Virtual Link 106. At the far end, a receiving ATM inverse multiplexer recombines the cells from each link, on a cell by cell basis, recreating the original ATM cell stream 110 which is then passed onto the ATM layer.”).

284. Figure 3 in Counterman further evidences that Counterman meets this claim element. Figure 3 is a “protocol reference model” that “includes a number of links **202** which nominally have the same cell transfer delay (CTD) but different nominal cell rates (NCRs).... [F]lows **212** (flow-1, flow-2, ... flow-n) collectively make up a single IMA virtual link **222.** Each

flow **212** corresponds to a link **202.** Each physical link **202** includes a Transmission Convergence sublayer **204** and a Physical Medium Dependent sublayer 206":

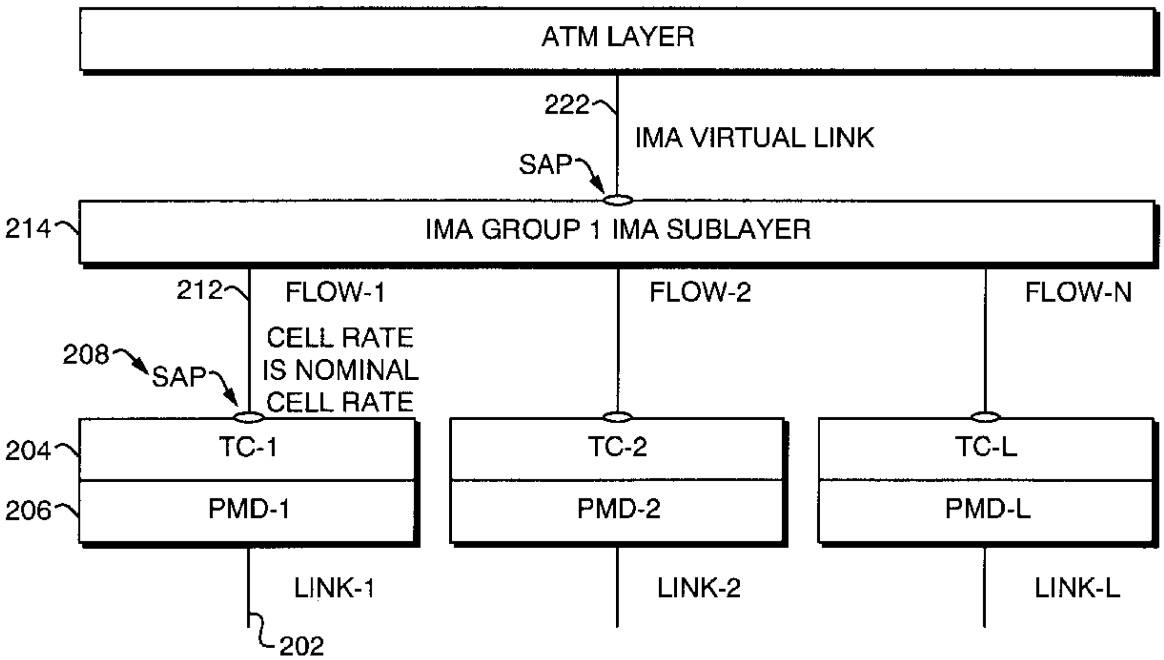

FIG. 3

Counterman at 6:8-18 & Fig. 3.

285. Figure 3 of Counterman shows TC **204** and PMD **206** elements associated with each link, which are associated with a transceiver. *See, e.g.*, ITU-T G.992.1, § 5.1.2 ("Figure 5-2 is a block diagram of an ADSL Transceiver Unit- Central office (ATU-C) transmitter showing the functional blocks and interfaces that are referenced in this Recommendation for the downstream transport of ATM data"); *id.* Fig. 5-2/G.992.1 (entitled "ATUC transmitter reference model for ATM transport" showing "Cell TC"); *id.*, App. I, Fig. I. l/G.992.1 ("ATM to physical layer logical interface at ATU-C and ATU-R," also showing "Cell TC").

286. Further, a person of ordinary skill in the art as of the '881 patent's priority date would have understood that xDSL communication is achieved using xDSL transceivers, each of

which has a transmitter portion and a receiver portion that share at least some common circuitry, e.g., an analog front end. Counterman discloses use of IMA in xDSL systems, including ADSL and VDSL. *See, e.g.,* Counterman at 3:25-31; 4:16-58. One of ordinary skill in the art would understand Counterman's references to ADSL to include the standardized version of ADSL at that time: ADSL as standardized in ITU-T G.992.1. A person of ordinary skill in the art would understand that an ADSL modem as described in ITU-T G.992.1 is communications device capable of transmitting and receiving data wherein the transmitter portion and receiver portion share at least some common circuitry. The use of common circuitry between the transmitting and receiving portions, including analog interface circuitry, integrated circuit assemblies, and digital signal processors, was typical at the time.

287. In addition, in 1998, PairGain Technologies, my employer at that time, designed an integrated DMT ADSL transceiver that used shared common circuitry between its transmitting and receiving functions. Based on my knowledge of the industry at that time, I am also aware that Aware, the original assignee of the Family 2 patents, designed an ADSL transceiver that employed shared common circuitry between its transmitting and receiving functions. I was not aware of any ADSL transceivers in or around February 1999 that did not share common circuitry between their transmitting and receiving functions.

288. Thus, one of ordinary skill in the art at the time of the alleged invention would have understood that each bonded communication link of Counterman is provided by a transceiver as construed by the Court, and the bonded communication links constitute a "plurality of bonded transceivers" as construed by the Court.

(2) <u>"each bonded transceiver utilizing at least one transmission parameter value to reduce a difference in latency between the bonded transceivers"</u>

289. It is my opinion that Counterman discloses this limitation.

within the IMA group have the same configuration latency reduces the difference in configuration between those bonded links.

296. Accordingly, it is my opinion that Counterman discloses this claim limitation through its teaching of grouping links together based on a sufficiently similar delay or latency.

297. Further, as noted, Counterman defines QoS objectives to include bounds on the delay that data may experience due to the selected FEC parameters. Limiting the maximum value for the delay on any one link also limits, or bounds, the differential delay between any two links. Counterman's grouping according to QoS parameters such as delay, further reduces the differential delay. *See* Counterman at 3:35-48 ("Multiple applications may share the xDSL bandwidth, and each of these applications may require a different Quality of Service (QoS). Because of the operational noise inherent in xDSL environments, forward error correction (FEC) is typically used to reduce the effects of noise and to meet the required QoS objectives. Convolutional interleaving may also be used to provide low cell loss in the presence of impulse noise, however, it often introduces delay. Therefore, in order to meet the desired performance requirements, a dual (or more complex) FEC approach is often used. The dual FEC approach provides a low delay path with greater cell loss probability and a high delay path with less cell loss probability.") *See also* ITU-T Recommendation G.992.1 (June 1999), Asymmetric Digital Subscriber Line Transceivers, at§ 7.6. Because Counterman provides an exemplary description of QoS and FEC parameters in connection with xDSL, a person of ordinary skill in the art at the time of the alleged invention would understand "FEC parameters" to include those of forward error correction techniques used in xDSL technologies at the time, which included Reed-Solomon and interleaving parameters such as codeword length and interleaving depth. *See, e.g.,* Tl.413-1995 at pp. 35-36.

298. Thus, Counterman teaches use of transmission parameter values that include an interleaving parameter value, a coding parameter value, and a codeword size value.

299. Thus, Counterman teaches that the transmission parameters control the configuration latency of a link and uses them to reduce a difference in configuration latency between two bonded transceivers, for example, to provide bonded transceivers that carry traffic having the same QoS requirements. I further understand that TQ Delta interprets "to reduce a difference in latency between the bonded transceivers" to occur when constraints on a maximum differential latency are placed on the transceivers during initialization such that the comparison (to determine whether a reduction has occurred) is drawn against what the differential configuration latency *might have been* in a hypothetical situation - specifically what it might have been if there had been no constraints on a maximum differential latency, and hence on the transmission parameters. Counterman explicitly teaches bonding links having FEC parameters selected to meet a common QoS objective, which a person of ordinary skill would understand includes a latency constraint. *See, e.g.,* Tl.413-1995 § 6.2.1.2.2 & Tables 18-19 (recognizing the relationship of interleaving and latency, and providing FEC coding parameters and interleave depth to provide certain default transport or QoS classes). Such bonding therefore provides reduced differential latency as compared to what it might have been, had the common QoS constraint not been imposed, or had the amount of latency permitted for a given QoS been different. Counterman therefore discloses utilizing at least one transmission parameter value to reduce a difference in latency between bonded transceivers, under TQ Delta's interpretation and application of the Asserted Claim.

300. In addition to the "simplified protocol reference model" described above (which itself is anticipatory) Counterman provides additional anticipating disclosure, for example, in

Figure 4 and Table 1:

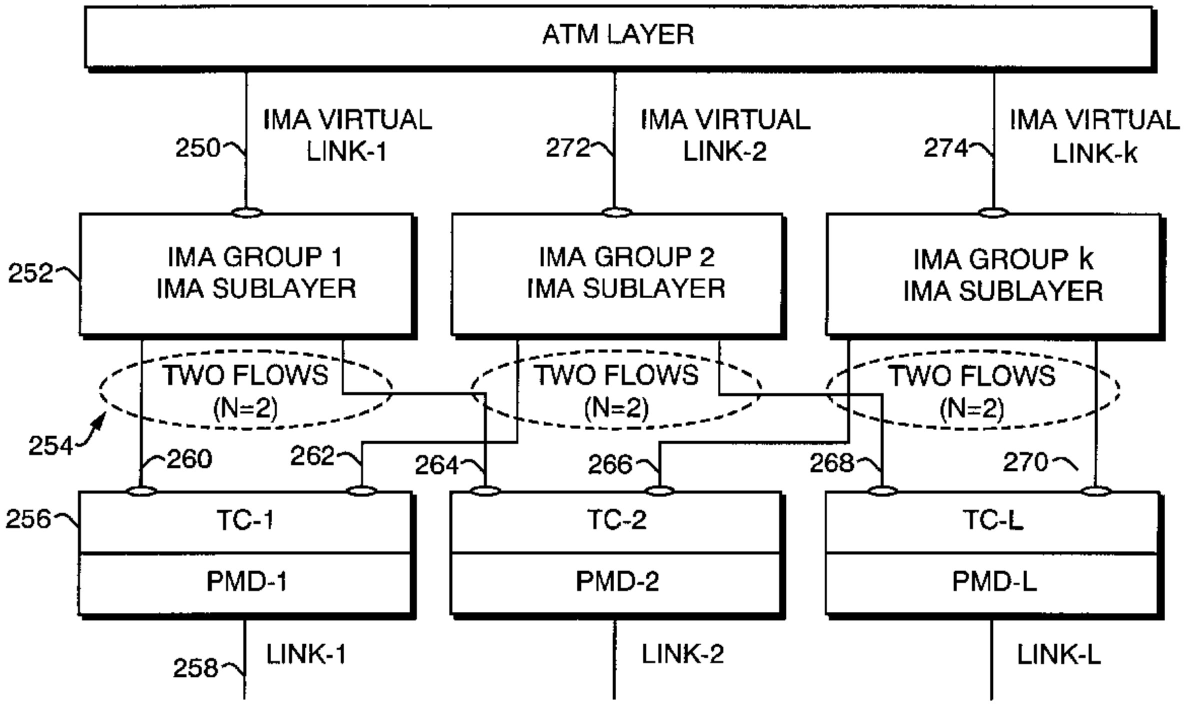

FIG. 4

TABLE 1

IMA Group	Rate (kcell/s)	Latency (ms)
TC-1, IMA Group 1, Flow 1 (260)	1	0.5
TC-1, IMA Group 2, Flow 1 (262)	5	4.0
TC-2, IMA Group 1, Flow 2 (264)	2	0.5
TC-2, IMA Group 3, Flow 1 (266)	4	10.0
TC-3, IMA Group 2, Flow 2 (268)	2	4.0
TC-3, IMA Group 3, Flow 2 (270)	8	10.0
IMA Virtual Link 1 (250)	3	0.5
IMA Virtual Link 2 (272)	7	4.0
IMA Virtual Link 3 (274)	12	10.0

Counterman Fig. 4 & Table 1. Counterman explains that "[t]he flows **254** in an IMA group may

have different nominal cell rates, but have the same nominal cell transfer delay, in order for the corresponding IMA virtual link **250** to meet the desired QoS objective." Counterman at 6:34-37 & Fig. 4. "Thus, [a]s shown in Table 1 and FIG. 4, the present invention groups cell flows which have the same latency (or delay) into a virtual link although they may have different cell rates, and then transmits using each cell flow at its respective rate." Counterman at 6:50-63 (Table 1), 7:6-10 & Figure 4.

301. Table 1 shows grouping transceivers, represented by their respective TC blocks, with the same latency (e.g., 0.5; 4.0; 10.0) but different rates to achieve a higher-rate bonded connection. Specifically, latency paths present in the multiple transceivers associated with the three depicted links that have the same configuration latency, but different rates, are bonded together. Thus, Counterman reduces differential configuration latency between links to zero by grouping together links with the same QoS represented by the common latency, which is in tum derived from the FEC and interleaving parameters used on those latency paths. Each link includes a transceiver that utilizes transmission parameter values, that is, the FEC and interleaving parameters, to have the same configuration latency and meet the common QoS objective for the group. This grouping therefore comprises bonded transceivers that utilize at least one transmission parameter value-which controls the configuration latency of the links—to reduce a difference in configuration latency among the members of the group bonded based on their identical configuration latencies.

(3) <u>"wherein a data rate for a first of the bonded transceivers is different than a data rate for a second of the bonded transceivers"</u>

302. It is my opinion that Counterman discloses this limitation.

303. Counterman "relates to inverse multiplexing for Asynchronous Transfer Mode ('ATM') over communication links with **different transmission rates and/or**

delays." Counterman at 1:8-11 (emphasis added). Counterman accomplishes this objective through ***"link grouping of communications links with different transmission rates and delay,"*** which "supports links which use a portion of the link bandwidth for one QoS objective (e.g., low delay) and another portion another QoS objective (e.g., low cell loss)." *Id.* at Abstract (emphasis added). *See also* 3:35-48; 4:16-5:13; 5:20-26; 6:8-13; 6:34-39; 6:48-7:12; Table 1.

304. One of ordinary skill in the art on the '881 patent's priority date would have understood that the transmission rates referred to in Counterman are the "data rates" of claim 17.

305. Counterman further discloses in Figure 3 "a block diagram of ATM inverse multiplexing of multiple links and flows" (Counterman at 5:44-45 & Fig. 3) and in Figure 4 a "model for flexible ATM inverse multiplexing according to the present invention" wherein "[t]he flows **254** in an IMA group may have different nominal cell rates" *(id.* at 6:27-36 & Fig. 4). One of ordinary skill in the art on the '881 patent's priority date would have understood that in these examples a data rate for a first of the bonded transceivers is different than a data rate for a second of the bonded transceivers.

306. It is therefore my opinion that Counterman discloses each of the limitations of claim 17 of the '881 patent, such that it anticipates and/or renders obvious, and therefore invalidates, that patent claim.

b. <u>Claim 23</u>

307. It is my opinion that Counterman discloses and/or renders obvious each limitation of Claim 23. As I explained above, Counterman discloses and/or renders obvious each limitation of claim 17, from which claim 23 depends. It is my opinion that Counterman further discloses that the at least one transmission parameter value is a first interleaving parameter value that is

different than a second interleaving parameter value for the second transceiver.

308. For example, in the context of discussing "nominal cell transfer delay," Counterman describes "selecting certain FEC parameters in order to meet a desired, common QoS objective." Counterman at 6:8-22. One of ordinary skill in the art at the time of the alleged invention would have understood an "FEC parameter" to be a transmission parameter value that includes interleaving parameter values. *See* Counterman at 3:35-48 ("Multiple applications may share the xDSL bandwidth, and each of these applications may require a different Quality of Service (QoS). Because of the operational noise inherent in xDSL environments, forward error correction (FEC) is typically used to reduce the effects of noise and to meet the required QoS objectives. Convolutional interleaving may also be used to provide low cell loss in the presence of impulse noise, however, it often introduces delay. Therefore, in order to meet the desired performance requirements, a dual (or more complex) FEC approach is often used. The dual FEC approach provides a low delay path with greater cell loss probability and a high delay path with less cell loss probability."). Because Counterman provides an exemplary description of QoS and FEC parameters in connection with xDSL, a person of ordinary skill in the art at the time of the alleged invention would understand "FEC parameters" to include those of forward error correction techniques used in xDSL technologies at the time, which included Reed-Solomon and interleaving parameters such as codeword length and interleaving depth. *See, e.g.,* Tl.413-1995 at pp. 35-36.

309. Counterman also explains that "[c]onvolutional interleaving may also be used to provide low cell loss in the presence of impulse noise, however, it often introduces delay. Therefore, in order to meet the desired performance requirements, a dual (or more

complex) FEC approach is often used. The dual FEC approach provides a low delay path with greater cell loss probability and a high delay path with less cell loss probability." Counterman at 3:41-48. One of ordinary skill in the art on the '881 patent's priority date would have understood that convolutional interleaving is characterized by interleaving parameter values such as interleaving depth. Accordingly, one of ordinary skill in the art would understand Counterman to disclose that the first and second transceivers can utilize different interleaver parameters values, such as interleaving depth, to reduce a difference in latency between the transceivers.

310. It is therefore my opinion that Counterman discloses the limitation of claim 23 of the '881 patent, such that it anticipates and/or renders obvious, and therefore invalidates, that patent claim.

2. Counterman in View of Djokovic

311. As set out above, it is my opinion that Counterman fully discloses all elements of claims 17 and 23 and thus anticipates both claims. To the extent any elements of claims 17 and 23 are determined not to be explicitly disclosed in Counterman, it is my opinion that they are obvious over Counterman in combination with Djokovic.

312. I incorporate my analysis of Counterman in Section XII.A.1 by reference.

a. Claim 17

(1) "A plurality of bonded transceivers"

313. It is my opinion that Counterman discloses this limitation. I incorporate my discussion above in Section XII.A.1.a.(1) by reference.

(2) "each bonded transceiver utilizing at least one transmission parameter value to reduce a difference in latency between the bonded transceivers"

314. It is my opinion that Counterman discloses this limitation. I incorporate my